REMARKS

Applicant hereby replies to the Office Action dated June 4, 2010. Applicant thanks the Examiner for carefully considering the application.

Status of Claims

Claims 1, 3-27 and 29-41 are pending in the above-referenced patent application. Claims 1, 31, and 32 are independent. Claims 34-41 are new.

Claims 1, 3-27, 29-33 were rejected under 35 U.S.C. §112 as failing to comply with the written description requirement. Claims 1, 3, 6-8, 11-24 and 31-33 were rejected under 35 U.S.C. §103(a) as being unpatentable over prior art.

Claim Amendments

Claims 1, 3, 31, and 32 are amended for clarification. No new matter is added.

Rejections under 35 U.S.C. §112 – Claims 1, 3-27, 29-33

Following the Office Action's recommendation, Applicant has removed the requirement of "entire" solution remaining in the liquid phase from the claims. Therefore, withdrawal of rejections under this basis is respectfully requested.

Rejections under 35 U.S.C. §103(a) – Claims 1, 3, 6-8, 11-24 & 31-33

Claims 1, 3, 6-8, 11-24, and 31-33 were rejected under 35 U.S.C. §103(a) as being

obvious over EP 0680810 A1 ("EP 810") in view of admitted state in the art (ASA) and "Boiling." Applicant respectfully traverses these rejections because, for at least the following reasons, EP 810 does not disclose all of the claimed limitations described in the current application.

Contrary to the Office Action's of the position, EP 810 does not disclose preheating the working solution to 150°C prior to adding the working solution to the wood, and does not *inherently* teach maintaining a pressure *throughout the preheating step* to ensure that the working solution is maintained in the liquid phase. Instead, EP 810 explicitly states, in part, that "[T]he added acetic anhydride solution is either warm, i.e. the temperature of the solution is in the range of 30-150°C, *or cold, i.e. the temperature of the solution is less than 70°C.* In the latter case, the cold solution is heated *during impregnation*." See EP 810, p.3, lines 14-16. This is obviously in contrast to the amended independent claim 1 of the current application, in which both preheating the working solution and maintaining pressure throughout the preheating step to ensure that substantially all of the working solution is maintained in liquid phase is not an option, but a requirement.

The Office Action also states that the claims of the current application fail to require all the acetylating agent to remain in liquid form, and therefore they are open to include a portion of the working solution being in vapor phase. As amended, independent claim 1 now requires, in part,

a. preheating a working solution comprising acetic anhydride to a temperature above the atmospheric boiling point of the working solution to form a working solution at a super hot temperature, wherein sufficient pressure is applied throughout the preheating step to ensure *substantially all of the working solution is maintained in a liquid phase and not vaporized*;

and

b. contacting a wood or wood based material with the working solution at said super hot temperature and at an elevated pressure such that *substantially all of the working solution is maintained in the liquid phase and not vaporized*, to cause impregnation of the liquid phase solution into the wood or wood based material (emphasis added).

Similarly, independent claim 31 now requires, in part,

a. preheating a working solution comprising acetic anhydride to a temperature above the atmospheric boiling point of the working solution to form a working solution at a super hot temperature, at an elevated pressure sufficient to maintain *substantially all of the working solution in the liquid phase and not in the vapor phase*;

and

b. applying a pre-pressure to a wood or wood based material prior to contact with the working solution at the super hot temperature, sufficient to maintain *substantially all of the working solution in the liquid phase and not in the vapor phase* (emphasis added);

and independent claim 32 now requires, in part,

a. preheating a working solution comprising acetic anhydride to a temperature above the atmospheric boiling point of the working solution to form a working solution at a super hot temperature, at an elevated pressure sufficient to maintain *substantially all of the working solution in the liquid phase and not in the vapor phase*;

These amendments to independent claims 1, 31, and 32 are supported by the specification of the current application. The specification explicitly provides that the working solution is impregnated into the material in the liquid phase at a temperature above its boiling point, *at a pressure which will maintain the working solution in the liquid phase*. Typically, the working solution will be preheated to a temperature above boiling point (the "super hot temperature") under a pressure *which ensures the working solution remains in the liquid phase*. See p. 5, lines 15-19. Further, the alternative described in lines 19-24 of the current application provides that

the working solution may be preheated to the super hot temperature at a pressure not sufficient to maintain the working solution in liquid phase *provided that pressure is subsequently applied so that when the working solution contacts the wood or wood based material, the working solution is in liquid phase.* See p. 5, lines 19-24. Even more clearly, the specification explicitly states that "[I]ncluded within the scope of the invention is the preheating of the *gaseous working solution* which is subsequently condensed by the application of sufficient pressure *so that the working solution is in the liquid phase when it contacts the wood or wood based material*." See p. 5, lines 25-28. Lastly, the specification states that the suitable pressure ranges for the pre-pressure stage are pressures sufficient to stop the solution from boiling at the elevated temperature. See p. 7, lines 16-17.

Therefore, contrary to the Office Action's position, the claims of the current application are not open to a portion of the working solution being in the vapor phase. As disclosed by the specification and the amended claims 1, 31, and 32, it is clear that the current application requires substantially all of the working solution in the liquid phase and not in the vapor phase.

EP 810, on the other hand, does not disclose the requirement of preheating the working solution to a temperature above the atmospheric boiling point to a form a working solution at a super hot temperature and applying sufficient pressure *to ensure that substantially all of the working solution is maintained in the liquid phase and not vaporized.* On the contrary, EP 810 explicitly states that its initial process of impregnating wood with acetylating agent may be carried out in five different options as set out below.

1. A vacuum is first applied to the container containing the solid wood, and subsequently liquid acetic anhydride is added to the container containing the solid wood.

2. A preliminary pressure is first applied to the container containing the solid wood, and subsequently liquid acetic anhydride is added to the container containing the solid wood.

3. A container containing the solid wood is filled with liquid acetic anhydride, and a vacuum is subsequently applied to the container containing the mixture of the wood and the liquid during and after the acetylation reaction step.

4. A container containing the solid wood is filled with liquid acetic anhydride, and a pressure is subsequently applied to the container containing the mixture of the wood and the liquid during and after the acetylation reaction step.

5. Acetic anhydride is applied to the container containing the solid wood directly with no preliminary pressure, preliminary vacuum or further vacuum. See EP 810, p. 3, lines 6-13; see also *Fig.*

EP 810 makes it very clear instances when a pressure or vacuum is to be applied, and the flow chart in *Fig.* also reflects the same accordingly. Therefore, following the teaching of EP810, a skilled person would not apply pressure or a vacuum unless it is explicitly stated. Here, as demonstrated, at no point is there any mention or depiction in EP 810 of preheating the working solution to a super hot temperature and applying pressure to the superhot working solution prior to its addition to the solid wood, *to ensure that substantially all of the working solution is maintained in the liquid phase and not vaporized.*

EP 810 discloses heating acetic anhydride to 150°C, which is given as an upper limit. As acetic anhydride has a boiling point of 139.8-140°C, some of it will be in the vapor phase upon heating to 150°C. Referring to the Office Action's reference entitled "Boiling Point," liquid in a vacuum environment has a lower boiling point than when the liquid is at atmospheric pressure;

whereas liquid in a high pressure environment has a higher boiling point than when the liquid is at atmospheric pressure. In other words, the boiling points of liquids vary with and depend upon the surrounding environmental pressure, and different liquids at a given pressure boil at different temperatures. See *http://en.wikipedia.org/wiki/Boiling_point*.

Applicant notes, however, such as in option 3 provided in EP 810 above, in which the container containing the solid wood is filled with liquid acetic anhydride and a vacuum is applied during as well as after the filling process, applying vacuum to the working solution would lower its boiling point. Hence, if the acetic anhydride is heated to 150°C and added to a container of solid wood under vacuum, the proportion of acetic anhydride in the vapor phase would increase as the boiling point of the acetic anhydride is lowered. Clearly, given the applied vacuum, no pressure is maintained to ensure the acetic anhydride solution remains liquid. Additionally, EP 810 provides only two examples: neither of these impregnates wood under pressure. Instead, a vacuum is applied, which lowers the boiling point of the mixture and increases the concentration of the vapor phase. Based on this, in contrary to the Office Action's position, an ordinary skilled person in the art reading EP 810 would conclude that it is of no importance if the acetic anhydride solution is boiling off during the impregnation step. In other words, upon reading EP 810, it would not have been obvious to a person with ordinary skill in the art to appreciate and reap the benefits of application of a liquid working solution. Therefore, Applicant respectfully submits that EP 810 does not teach that a pressure is maintained throughout the preheating step *to ensure substantially all of the working solution is maintained in a liquid phase and not vaporized*. There is simply no disclosure of this in EP 810.

The Office Action notes that EP 810 discloses a few minutes of impregnation. However,

EP 810 also discloses that its process is suitable for material such as chips and flakes. See EP 810, p. 3, line 1. Also, as stated on page 3, lines 21 to 23, impregnation in a range of a few minutes to several hours depends on the dimensions and wood species used. Hence, an impregnation process of a few minutes according to EP 810 is only possible for very small pieces of wood, such as chips and flakes.

On the contrary, the new claim 39 in the current application requires,

> The process according to claim 1 wherein the wood or wood based material is relatively large pieces of wood;

the new claim 40 requires,

> The process according to claim 31 wherein the wood or wood based material is relatively large pieces of wood;

and the new claim 41 requires,

> The process according to claim 32 wherein the wood or wood based material is relatively large pieces of wood;

In experiment 1, described on page 11 of the current application, relatively large pieces of pine measuring 300 x 60 x 45mm or 300 x 20 x 20mm (both about a foot long) were acetylated under temperatures ranging from 141°C to 194°C. See column 5 of table 1 on page 13. Referring to page 14 line 13 to page 15 line 2, acetylation bulks the wood cell wall and the resulting oven-dried volume of the wood increases. Figure 4 shows this effect and the close relation between bulking and anti-shrink efficiency (ASE). It is believed that the volume increase resulting from the bulking of wood by acetylation is the main cause of ASE

improvement. The last column of table 1 sets out the oven dried volume increase as a percentage. It can be seen that using a maximum temperature of 191°C under an extra pressure of 500 kPa resulted in the largest oven-dried volume increase of 12.9% and a reacted weight gain after 48 hours of drying in an oven of 29.8%. See treatment 8. Page 14 line 9 notes that a 28% weight gain is very close to the maximum theoretical reaction by acetylation. It can therefore be appreciated that, in the experiments disclosed in the present application, almost maximum acetylation is achieved using the process claimed. This degree of acetylation was achieved in only **79 minutes** and this is one of the longest reaction times used in the 19 experiments set out in table 1. See column 10. By way of example, good results (i.e., an oven-dried volume increase of 9.1% and a reacted weight gain after 48 hours of drying in an oven of 23%) were also achieved by treatment 10 using a maximum temperature of 170°C under an extra pressure of 500 kPa in only **41 minutes** (including recovery of by-products). In contrast, the maximum weight gain that can be achieved by EP 810 is merely 24%, after a drying treatment that can take up to 10 days. See EP 810, p. 4, line 10-14.

The rapid reaction time of the process of the present invention is mentioned in the description of the current application. See page 5 line 33 to page 6 line 1. It states how carrying out the impregnation in the liquid phase enables sufficient loading of acetic anhydride in the wood to be achieved to substantially enhance decay and insect resistance and dimensional stability of the wood in the shorter processing time.

These results are achieved using a working solution comprising acetic anhydride by the steps of: pre-heating the working solution to a super hot temperature under sufficient pressure to

maintain substantially all of the working solution in liquid phase and not in vapor phase; contacting wood with the working solution at the super hot temperature and at an elevated pressure such that substantially all of the working solution remains in the liquid phase and not in the vapor phase; and separating the wood from any remaining working solution, waste material and/or by- products.

The Office Action is also of the position that the prior art explicitly disclosed 150°C as a temperature, and this is within the range claimed by the current application. The Office Action believes that that a prima facie case of obviousness exists where the claimed ranges and prior art do not overlap, but are close enough that one in ordinary skill in the art would have expected them to have the same properties. However, Applicant respectfully submits that although the temperature range claimed by the current application are close to the temperature range of the prior art, EP 810 and the current application do not exhibit the same properties.

In addition to the discussion above on the results achieved by the current application, page 11 lines 4 to 9 of the current application states that when compared to the existing prior art vapor phase acetylation processes, the super hot temperature liquid phase acetylation process of the current application reduces the process time that would otherwise be required at the temperature used to achieve reaction in a single stage or vessel in a vapor phase impregnation process. At the same time, the current application achieves a much higher deposit of acetic anhydride in the wood, sufficient to significantly enhance wood resistance to decay and insect attack and dimensional ability, for example. As set out above, and also in accordance with the teaching of the present invention, there are clear technical effects which can be associated with the higher temperature of the working solution, these effects not being obvious.

It is counter-intuitive to acetylate wood at super hot temperatures. This is because, as wood is acetylated, it causes swelling due to the larger size of the acetyl group compared to the hydroxyl group it replaces. This makes the wood more dense and hinders the progress of acetic anhydride into the interior of the wood. Acetylation using super hot temperature acetic anhydride would not be considered as useful since it would be thought that the wood would swell too quickly for the acetic anhydride to impregnate properly. Consequently, very rapid impregnation has not before been considered.

It is also noted that the initial high temperature of the working solution facilitates the removal of corrosive unwanted acetic acid. See page 9 lines 22 to 27. As mentioned above, EP 810 only has two examples; neither of these impregnate wood under pressure. Instead, a vacuum is applied which lowers the boiling point of the mixture. In example 1, wood samples of beech and popular are used and it is stated that these woods species can easily be impregnated. Example 2 is more relevant as here wood samples of pine sapwood are impregnated having dimensions of 30 x 30 x 150 mm (1 x 1 x 6 inches); this is quite a bit smaller than the pieces of pine impregnated in the experiments of the present application. These wood samples of EP 810 were impregnated under vacuum and acetylated in a pre-heated glass vessel at 120°C for 3 hours. The weight gain due to acetylation is not provided. However, assuming acceptable levels of acetylation occurred, this took 3 hours to achieve compared to the good results achieved in 41 to 79 minutes of the present invention for a significantly larger piece of pine.

Based on the above, Applicant respectfully submits that although the temperature range of EP 810 is close to the temperature range of the current application, both exhibit significantly different results and different properties.

CONCLUSION

In view of the foregoing amendments and remarks, Applicant believes that the claims are in condition for allowance. Reconsideration, re-examination, and allowance of all claims are respectfully requested. If the Examiner feels that a telephone interview may help further the examination of the present application, the Examiner is encouraged to call the undersigned attorney or his associates at the telephone number listed below.

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Respectfully submitted,

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